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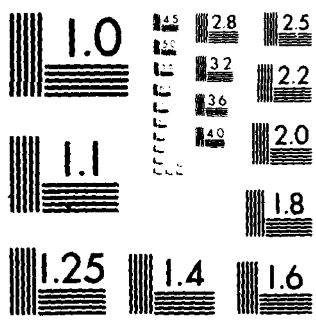

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EFFECT OF AIR CONTENT ON BROADBAND NOISE MEASUREMENTS IN THE 1.22-m DIAMETER WATER TUNNEL

B. E. Robbins and D. E. Thompson

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The effect of air content on broadband radiated noise in the 1.22-m diameter water tunnel was investigated. In addition, tunnel operating pressure was also varied. The transmitting hydrophone was positioned in the tail of an axisymmetric body mounted in the test section. Two receiving transducers were used. Both showed a somewhat systematic change in broadband spectral levels with variations in air content up to 11 parts per million and variations in pressure.

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Subject: Effect of Air Content on Broadband Noise Measurements in the 1.22-m Diameter Water Tunnel

Abstract: The effect of air content on broadband radiated noise in the 1.22-m diameter water tunnel was investigated. In addition, tunnel operating pressure was also varied. The transmitting hydrophone was positioned in the tail of an axi-symmetric body mounted in the test section. Two receiving transducers were used. Both showed a somewhat systematic change in broadband spectral levels with variations in air content up to 11 parts per million and variations in pressure.

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INTRODUCTION

An experimental study was conducted in the 1.22-m diameter water tunnel to determine the effects of air content on measured broadband noise. A single transmitting hydrophone and two receiving transducers were used in the test. The air content, static tunnel pressure, and flow velocity were varied for these measurements.

The purpose of this study was to determine the effects of the air content on the sound transmission in the water tunnel. The results and conclusions of this study are presented in this report.

INSTRUMENTATION

The transmitting hydrophone was installed in the tail of an axisymmetric body which was mounted in the test section of the 1.22-m diameter Garfield Thomas Water Tunnel of the Applied Research Laboratory at The Pennsylvania State University. The inflow hydrophone and downstream array were mounted in the water tunnel as shown in Figure 1. An LC-32 hydrophone was used as the transmitter. It was encased in a plexiglass tailcone which was virtually acoustically transparent in the water medium. This plexiglass covering's exterior surface matched the contour of the vehicle's tail section and replaced the propeller hub and spinner. The electrical connections were brought forward in the test body and out through its support strut.

The inflow hydrophone and downstream array were mounted at their normal tunnel positions, see Figure 1. A block diagram of the transmitting and receiving circuits is shown in Figure 2. A General Radio white noise generator produced the input to the LC-32 which transmitted it into the environment. The input rms voltage was monitored on a voltmeter. The received signals were amplified and then analyzed on a Spectral Dynamics (SD) 360 real time analyzer. Data analysis was performed in the 0 to 150 kHz range. The data were reduced in the same manner as in a standard acoustic measurement test. In each of the spectral analyses an antialiasing filter set at 20% below the upper frequency, part of the SD 360 system, was employed. Also, a high pass Khronhite filter, set at 25 kHz, was used.

TEST PROCEDURE

As the conclusion of the previous test in the water tunnel the air content had risen to 10.99 parts per million (ppm). During the present study, the water was partially deaerated between measurements to control the air content. The tunnel flow velocity was maintained at 6.1 m/sec and tunnel pressure held constant at 137.9 KPa while a water sample was taken and analyzed for its air content.

Acoustic spectra were obtained while the tunnel was operated at two flow velocities, 6.1 and 10.7 m/sec. At each velocity, the tunnel pressure was set to the following values: 137.9, 172.375, 206.85, and 241.325 KPa.

RESULTS

The results obtained are shown in Figures 3 through 10. Figures 3 through 6 show broadband noise spectra at different air contents while under constant operating conditions. Both sensors exhibited the same spread in the data. The spectra in Figures 5 and 6 had a high pass filter set at 40 kHz, which cutoff everything below that frequency. Each spectra has two distinct characteristics. At low frequencies (below about 75 kHz) air content has no effect on spectral level. At the higher frequencies the higher the air content the lower the spectral level. The maximum spread in the data was about 6.0 dB over the air content range of 3.1 to 10.99 ppm. Figures 3 and 4 showed that tunnel flow velocity variations had no effect on the spectra from the inflow sensor.

Figures 7 through 10 are cross plots of the spectral values at 75 kHz for the inflow sensor and 105 kHz for the downstream array plotted against the air content at various tunnel pressures. By holding the tunnel pressure constant at 137.9 KPa, the higher the air content the lower the spectral levels. The maximum variation in spectral level was no more than 6 dB; except at the highest air content which showed a 10 dB variation.

CONCLUSIONS

Based on the results the following conclusions can be drawn:

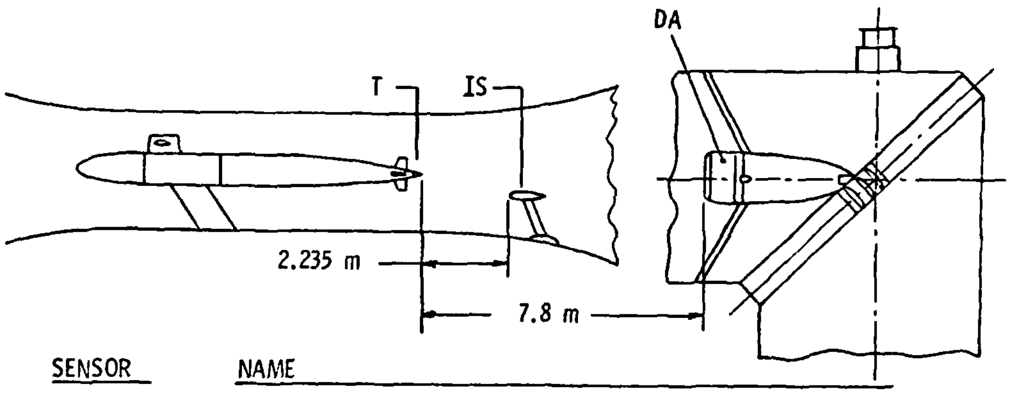
Below about 75 kHz, air content and pressure have no effect on sound transmission.

A general trend exists at frequencies at and above 75 kHz where the attenuation increases as the air content increases.

A general trend exists at frequencies at and above 75 kHz where the attenuation increases as the pressure decreases.

RECOMMENDATIONS

The narrowband analysis employed in the present investigation was not sufficient to allow a good definition of the trends of attenuation with air content and pressure. A repeat test should be conducted using 1/3 octave band analysis or greater so that exact variations can be established and subsequently applied to measured data.



SENSOR	NAME
DA	DOWNSTREAM ARRAY
IS	INFLOW SENSOR
T	LC-32 TRANSMITTING HYDROPHONE

Figure 1. Model Installation and Instrumentation

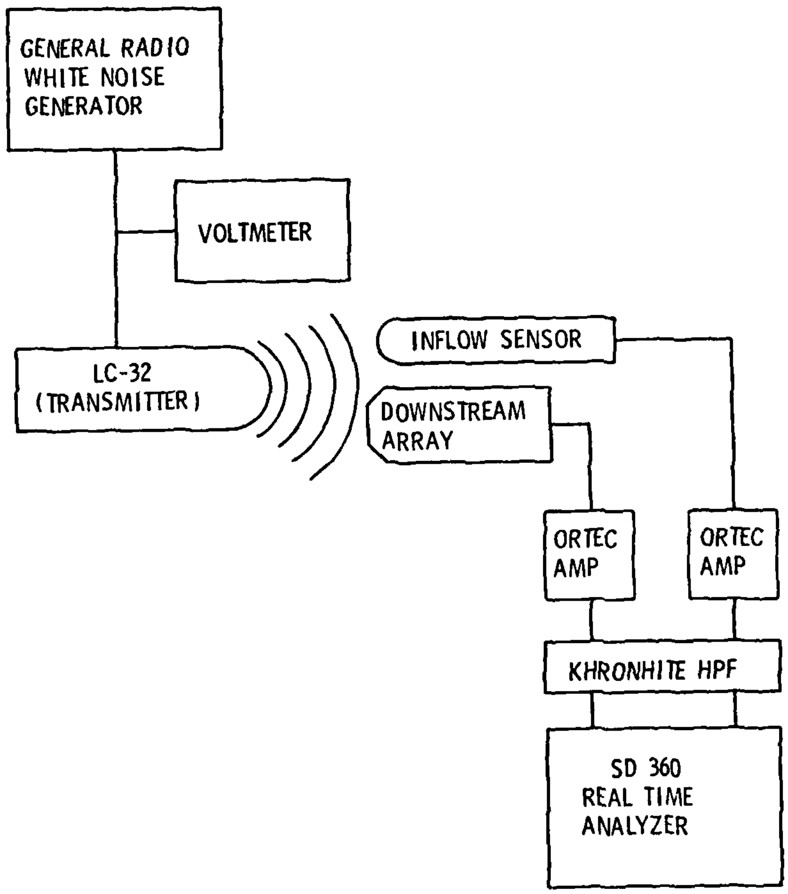


Figure 2. Schematic of Instrumentation Setup

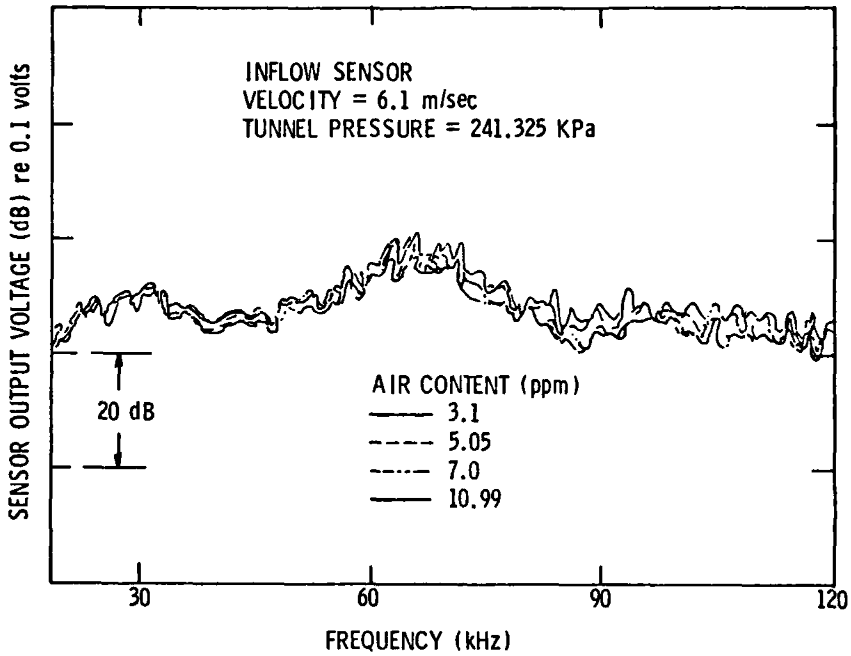


Figure 3. Broadband Noise Spectra at Various Air Contents: Inflow Sensor, Flow Velocity 6.1 m/sec, Tunnel Pressure 241.325 KPa

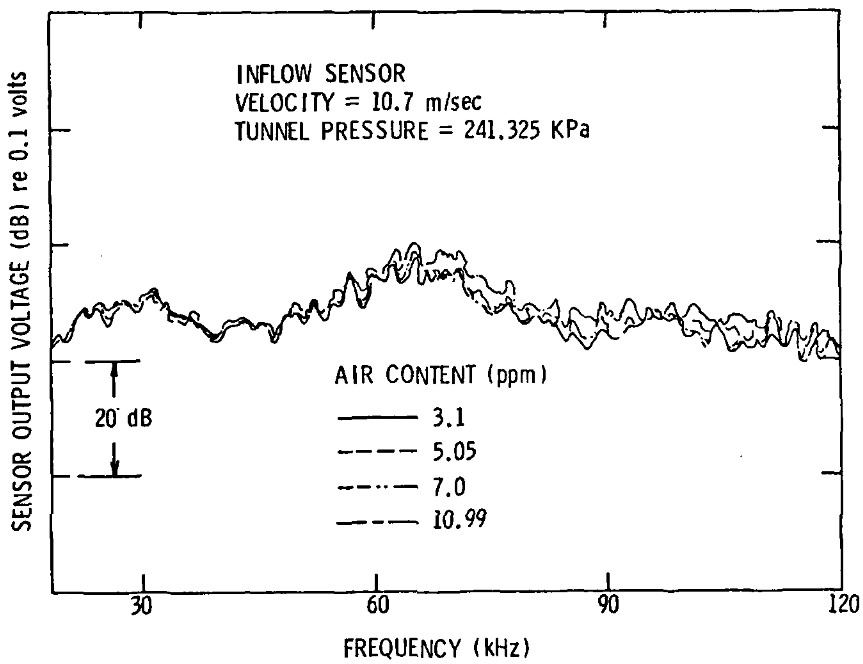


Figure 4. Broadband Noise Spectra at Various Air Contents: Inflow Sensor, Flow Velocity 10.7 m/sec, Tunnel Pressure 241.325 KPa

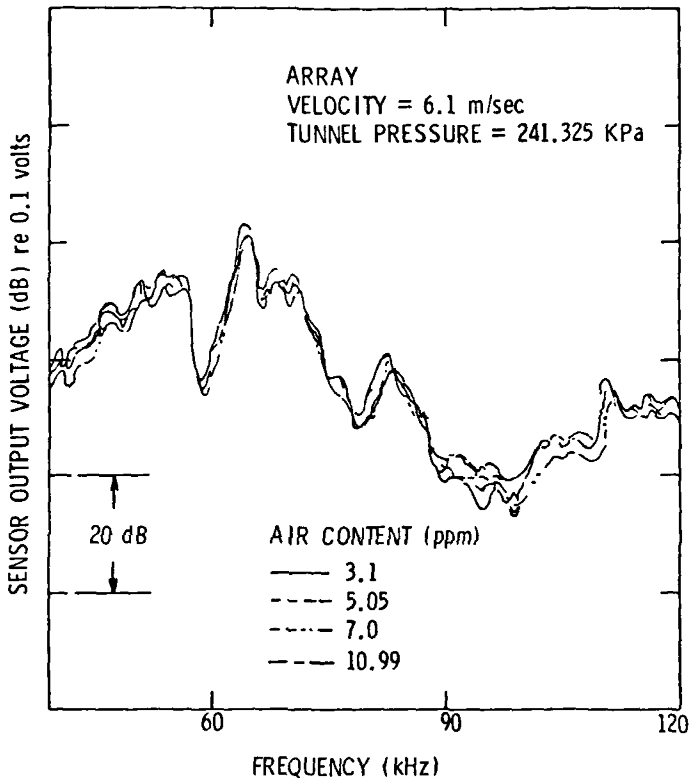


Figure 5. Broadband Noise Spectra at Various Air Contents: Downstream Array, Flow Velocity 6.1 m/sec, Tunnel Pressure 241.325 KPa

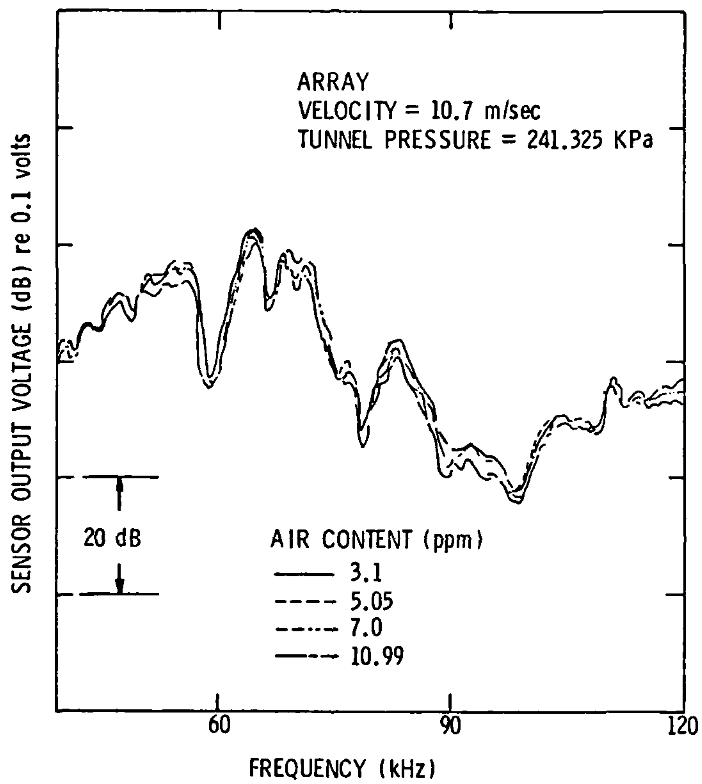


Figure 6. Broadband Noise Spectra at Various Air Contents: Downstream Array, Flow Velocity 10.7 m/sec, Tunnel Pressure 241.325 KPa

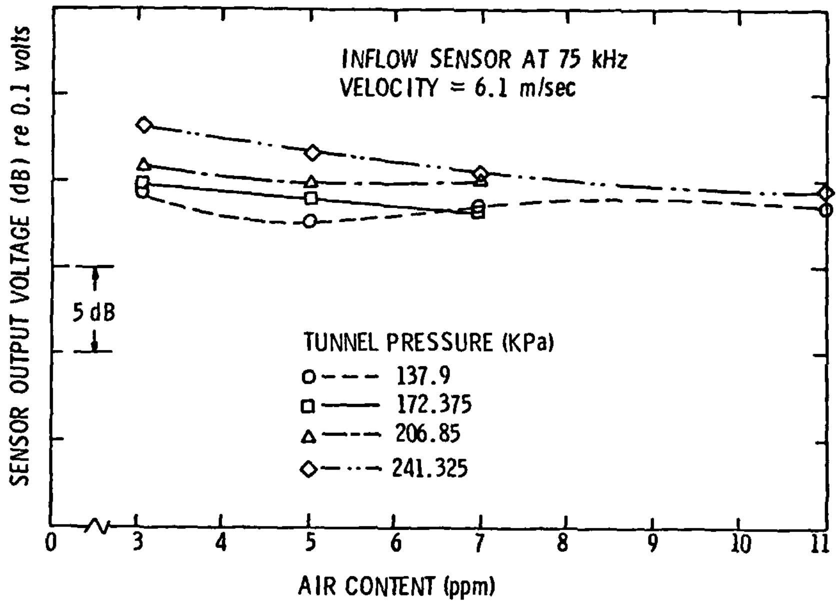


Figure 7. Broadband Noise at 75 kHz Versus Air Content at Various Tunnel Pressures: Inflow Sensor, Flow Velocity 6.1 m/sec

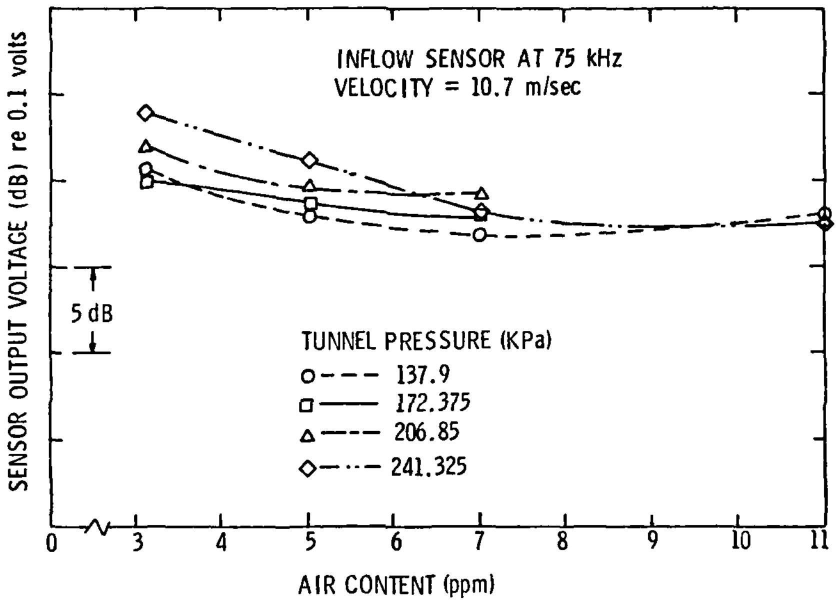


Figure 8. Broadband Noise at 75 kHz Versus Air Content at Various Tunnel Pressures: Inflow Sensor, Flow Velocity 10.7 m/sec

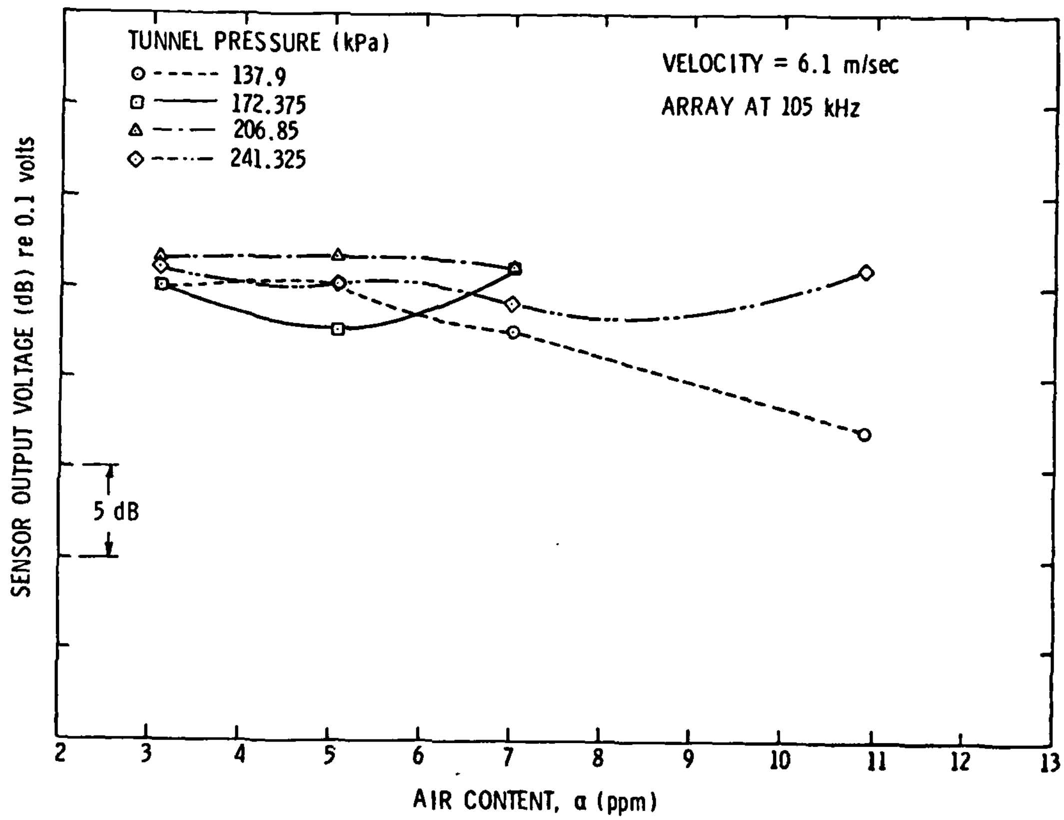


Figure 9. Broadband Noise at 105 kHz Versus Air Content at Various Tunnel Pressures: Downstream Array, Flow Velocity 6.1 m/sec

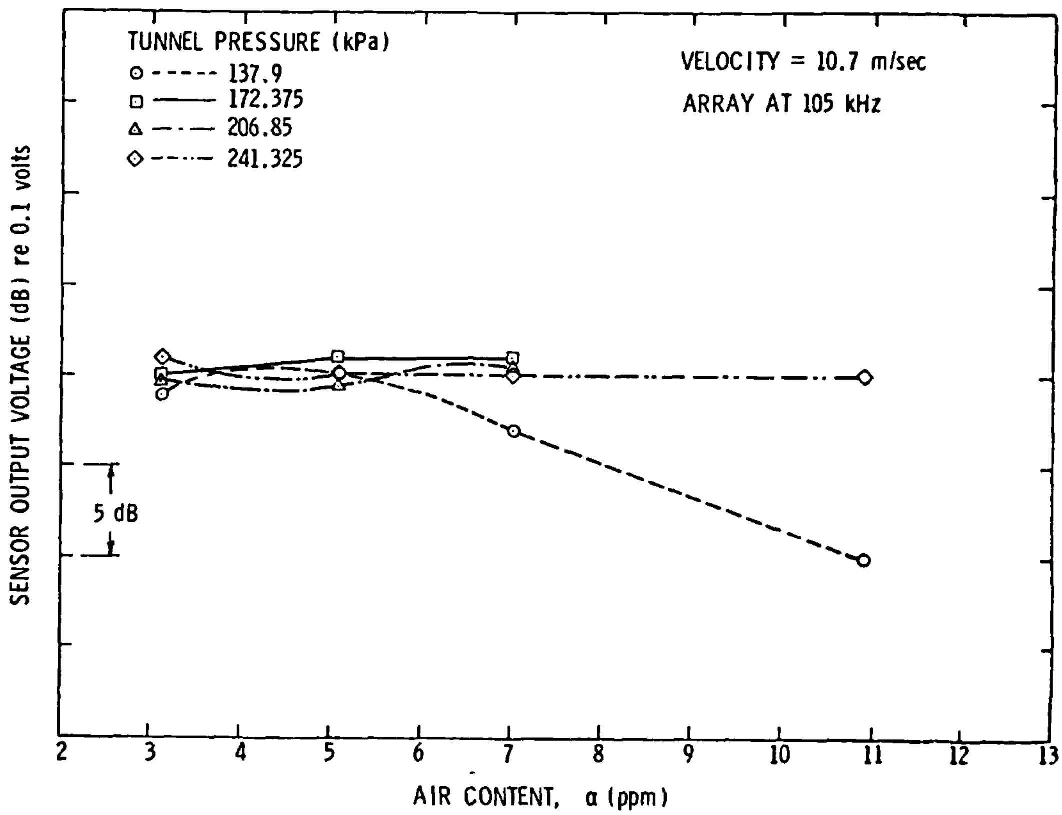


Figure 10. Broadband Noise at 105 kHz Versus Air Content at Various Tunnel Pressures: Downstream Array, Flow Velocity 10.7 m/sec

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